Estimating the Prevalence of Covid-19 Infectious Cases
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1. Overview.

The statements made below reflect my opinions in the matter of Abbey Hotel Acquisition, LLC, Setai Hotel Acquisition, LLC; Setai Resort & Residence Condominium Association, Inc, and Setai Valet Services, LLC versus National Surety Company. These opinions are based upon a reasonable degree of scientific certainty, based on the materials and methods detailed below. The purpose of this report is to trace the prevalence of infectious cases of COVID-19 in Miami-Dade county. In so doing, this report will ultimately render an opinion, based upon a reasonable degree of professional certainty, that COVID-19 was prevalent in Miami-Dade county around the time of the Miami-Dade Emergency Order issued on March 26th.

2. Summary of Analysis.

A statistical analysis is used to estimate prevalence of infectious cases of COVID-19 in Miami-Dade County in March of 2020. Based on review and analysis of available data, in Miami-Dade County, the estimate for the prevalence of infectious cases of COVID-19 was increasing in March of 2020, reaching 2.9 out of every 1000 persons on March 26, with a plausible range of 2.3 to 3.8 persons out of every 1000 persons on March 26.

The methodology comprises three steps.

1. Estimation of the number of infectious cases corresponding to recorded deaths attributed to COVID-19. The calculation uses the Infection Fatality Ratio ("IFR"), which is the number of individuals who die of COVID-19 out of all individuals infected by COVID-19, including both symptomatic and asymptomatic cases.
2. Distribution of these cases over an appropriate time interval, using currently available estimates of the duration between onset of infectiousness and death.
3. Computation of the total estimated infectious cases by day, using currently available estimates of duration of infectivity.

3. Infections and Deaths. The number of cases of COVID-19 in counties of interest is estimated using the relationship between infections and deaths, working backwards from deaths to cases using the Infection Fatality Ratio (IFR).

Definition: *The Infection Fatality Ratio (IFR) is defined as the number of individuals who die of COVID-19 out of all individuals infected by COVID-19 (including both symptomatic and asymptomatic cases).*

The definition closely follows that of the WHO[1], reproduced below.

[1] https://www.who.int/news-room/commentaries/detail/estimating-mortality-from-covid-19

$$\text{Infection fatality ratio (IFR, in \%)} = \frac{\textit{Number of deaths from disease}}{\textit{Number of infected individuals}} \text{ x } 100$$

Instead of using %, we report the IFR as a simple ratio, as explained in the example below.

Example 1: *If at a particular location one out of every 100 people infected with COVID-19 dies from COVID-19, this means the IFR for this location is 0.01.*

By the definition of IFR, each recorded death corresponds to 1/IFR cases of COVID-19 on average.

Example 2: *If the COVID-19 IFR for a given location is 0.01, this means that on average, one out of every hundred people infected with COVID-19 dies of COVID-19 in this location. Equivalently, every recorded death in the location corresponds to 1/0.01 = 100 COVID-19 cases, on the average.*

4. Estimation of IFR. CDC provides infection fatality ratio (IFR) estimates in their Planning Scenarios document[2], which is based on a peer-reviewed meta-analysis[3] that summarizes the relationship between age and IFR based on 27 studies containing data from 34 locations. Using the results of this meta-analysis, the CDC has provided detailed estimates of IFR by age group, reproduced here:

Table 1: IFR Estimation

Age	**Infection Fatality Ratio**	**Proportion of US Population in This Age group[4]**	**Proportion of Miami-Dade Population in This Age Group[5]**
0-17	0.00002	0.24	0.202
18-49	0.0005	0.44	0.433
50-64	0.006	0.19	0.199
65+	.09	0.13	0.167

4.1. Estimates of IFR for Locations. Since the IFR varies by age, the IFR for a given location is estimated by using the demographic structure for that location. The "Proportion of US Population" and "Proportion of Miami-Dade Population" columns in Table 1 provide the statistical weights used to estimate the IFR for the United States and for Miami-Dade county in the examples below.

Example 3: Estimating IFR for US and for Miami-Dade county
The IFR for the United States based on the CDC estimates of IFR and the 2010 census is given by

$$\mathrm{IFR} = (0.24 \times 0.00002) + (0.44 \times 0.0005) + (0.19 \times 0.006) + (0.13 \times 0.09) = 0.013.$$

[2] COVID-19 Planning Scenarios, Table 1, Accessed at https://www.cdc.gov/coronavirus/2019-ncov/hcp/planning-scenarios.html on 4/7/2021.
[3] Levin AT, Hanage WP, Owusu-Boaitey N, *et al*. Assessing the age specificity of infection fatality rates for COVID-19: Systematic review, meta-analysis, and public policy implications. *Euro J Epidemiol*. 2020;35(12):1123–1135.
[4] Population by Sex and Selected Age Groups: 2000 and 2010 www.census.gov/prod/cen2010/briefs/c2010br-03.pdf)
[5] https://www.census.gov/data/tables/time-series/demo/popest/2010s-state-detail.html

This means that on average, every death attributed to COVID-19 in the USA corresponds to 1/0.013 = 76.9 cases of COVID-19 in the USA.

The IFR for the Miami-Dade county based on the CDC estimates of IFR and age-structure of the Miami-Dade population is

$$\mathrm{IFR} = (0.202 \times 0.00002) + (0.433 \times 0.0005) + (0.199 \times 0.006) + (0.167 \times 0.09) = 0.0164.$$

This means that on average, every death attributed to COVID-19 in Miami-Dade county corresponds to 1/0.0164, or about 61.0 cases of COVID-19 in Miami-Dade county.

This analysis uses county-specific IFR estimates obtained using Table 1 and age structure by county.[6]

4.2. Accounting for Uncertainty in IFR Estimation.
The IFR is a quantity estimated from data using a statistical analysis based on 27 studies and 34 locations[7]. In addition to providing the estimates, the authors report 95% confidence intervals for IFR estimates across age groups. A preliminary look at these estimates shows that the lower bounds of the 95% confidence intervals for each reported group are greater than a factor of 0.75 times the estimate, while the upper bounds for each reported group are less than a factor of 1.25 times the estimate. Using these factors allows a preliminary estimate of the uncertainty of IFRs estimated by location, referred to as modified 95% confidence intervals below.

Example 4: estimating modified 95% confidence intervals for IFRs by location.
Using Table 1, the estimate for IFR in Miami-Dade county 0.0164, which corresponds to about 61.0 cases per recorded death. Using the maximal variation across 95% confidence intervals reported across age groups by Levin et. al, the corresponding modified confidence interval for Miami-Dade county for IFR is between 0.0166 x 0.75 = 0.0123 and 0.0166 x 1.25 = 0.0205, which corresponds to between 48.8 to 81.3 cases of Covid-19 infection per Covid-19 death in Miami-Dade county.

5. Timing of COVID-19.

5.1. Duration between Exposure and Death. The time between initial infection with COVID-19 and death from COVID-19 has been estimated by the CDC[8]. Time from exposure to symptom onset to death varies by age, as summarized below:

Table 2: Duration between Exposure and Death

Age	**Duration (Days) between Exposure and Death**

[6] https://www.census.gov/data/tables/time-series/demo/popest/2010s-counties-detail.html

[7] Levin AT, Hanage WP, Owusu-Boaitey N, *et al*. Assessing the age specificity of infection fatality rates for COVID-19: Systematic review, meta-analysis, and public policy implications. *Euro J Epidemiol*. 2020;35(12):1123–1135.

[8] COVID-19 Planning Scenarios, Table 2, Accessed at https://www.cdc.gov/coronavirus/2019-ncov/hcp/planning-scenarios.html on 4/7/2021.

0-17	10-37
18-49	16-36
50-64	17-36
65+	15-31

The current analysis uses a variable duration from 15 to 31 days.
Example 5: *A single death on April 1st, given IFR of 0.01, corresponds to 100 new infections occurring during March 1 to March 17, 15 to 31 days earlier than the date of death. Thus, on the average, there were 5.88 new infections for each of the 17 days from March 1 to March 17 (inclusive). Note: 100/17 = 5.88.*

5.2. Latent Period. The *latent period* is the time between exposure and the onset of infectiousness, with the best estimate of 3 days for COVID-19[9].

5.3. Duration of Infectivity. CDC recommends self-isolation for 10 days after symptom onset[10], which occurs on average 6 days after exposure[11],[12].

6. Estimation of Infectious Cases and Prevalence Over Time.

6.1 For each county of interest, IFR is estimated following the method detailed in Section 3.

6.2. For each recorded death attributed to COVID-19, 1/IFR cases are equally distributed over the 17-day period which is 15-31 days in the past, following section 4.1. Using the value of 3 for the latent period, each death corresponds to 1/IFR infectious cases equally distributed over the 17-day period 12-28 days in the past.

Example 6: *A single death on April 1st, given IFR of 0.01, corresponds to 5.88 infectious cases for each day from March 4th through March 20th.*

6.3. CDC estimates a mean duration of 6 days between exposure and symptom onset[13]. CDC guidelines from February 2021 indicate that adults quarantine/isolate for 10 days after symptom onset[14], giving a

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[9] Li, Ruiyun, et al. "Substantial undocumented infection facilitates the rapid dissemination of novel coronavirus (SARS-CoV-2)." *Science* 368.6490 (2020): 489-493.

[10] Interim Guidance on Duration of Isolation and Precautions for Adults with COVID-19 https://www.cdc.gov/coronavirus/2019-ncov/hcp/duration-isolation.html, accessed 4/7/21
[11] COVID-19 Planning Scenarios, Table 2, Accessed at https://www.cdc.gov/coronavirus/2019-ncov/hcp/planning-scenarios.html on 4/7/2021.

[12] McAloon C, Collins Á, Hunt K, *et al*. Incubation period of COVID-19: A rapid systematic review and meta-analysis of observational research. *BMJ Open*. 2020;10(8):e039652; Ma S, Zhang J, Zeng M, *et al*. Epidemiological parameters of COVID-19: Case series study. *J Med Internet Res.*2020;22(10):e19994.

[13] https://www.cdc.gov/coronavirus/2019-ncov/hcp/planning-scenarios.html
[14] https://www.cdc.gov/coronavirus/2019-ncov/hcp/duration-isolation.html

period of 16 days between exposure and end of infectivity. Between exposure and start of infectivity, there is a latent period estimated to last 3 days[15]. These duration parameters yield a period of 13 days of active infectivity. Each newly infectious case is therefore assumed to remain infectious for 12 days following the day it became infectious.

6.4. The total number of infectious cases for each calendar day is obtained by calculating the estimated number of infectious cases based on recorded deaths, and then tabulating infectious cases on each calendar day. Multiple different days with Covid-19 deaths may all contribute to the final tally of infectious cases on a given calendar day. To compute the prevalence of infectious cases on a given calendar day, the calculated number of infectious cases on that day is divided by the population of the county of interest on that day.

7. Prevalence Estimates for Miami-Dade County on March 26, 2020.

Death time series by day are obtained from the USAFacts website.[16]

7.1. Prevalence Estimates. This analysis is used to estimate daily prevalence of infectious cases of COVID-19 in Miami-Dade county in March 2020. Estimates of the prevalence of infections cases by day, obtained using the methodology described in this report, show that prevalence of infectious cases is on the rise during March. Estimates of prevalence of infectious cases in are provided for March 26th, together with modified 95% confidence intervals, using on the methodology detailed in Section 4.2.

Table 3: Prevalence of Infectious Cases Estimated on March 26th 2020 in Miami-Dade County

Estimated Prevalence of Infectious Cases	Modified 95% Confidence Interval for Estimated Prevalence of Infectious Cases
0.0029	(0.0023, 0.0038)

7.2 Explanation of Results

Table 3 presents estimates of the prevalence of infectious cases of COVID-19 in Miami-Dade County on March 26 2020, together with a plausible range for these estimates. After accounting for uncertainty of IFR estimation, the minimal prevalence on March is higher than 0.0023 (the lower bound of the modified 95% confidence interval), which means more than 2.3 in every 1000 persons were infectious with COVID-19 on March 26th . The current best estimate for prevalence of infectious cases of COVID-19 on March 26th 2020, is 0.0029 for Miami-Dade County. The upper limit of the modified 95%

[15] Li, Ruiyun, et al. "Substantial undocumented infection facilitates the rapid dissemination of novel coronavirus (SARS-CoV-2)." *Science* 368.6490 (2020): 489-493.

[16] US Covid-19 Cases and Deaths, https://usafacts.org/visualizations/coronavirus-covid-19-spread-map/, accessed 4/8/21.

confidence interval shows that the prevalence of infectious cases of COVID-19 on March 26th 2020 may have been higher, up to 0.0038 in Miami-Dade County.

8. Conclusion.

A statistical analysis is used to estimate prevalence of infectious cases of COVID-19 in Miami-Dade County in March of 2020. Based on review and analysis of available data, in Miami-Dade County, the estimate for the prevalence of infectious cases of COVID-19 was increasing in March of 2020, reaching 2.9 out of every 1000 persons on March 26, with a plausible range of 2.3 to 3.8 persons out of every 1000 persons on March 26, 2020.